EXPLANATION

GEOLOGY GENERALIZED AND REVISED FROM BROSGE AND REISER. 1964 . AND CHIPP. 1970

CORRELATION OF MAP UNITS

Qu } QUATERNARY

SURFICIAL DEPOSITS

FOSSILIFEROUS, PARTLY METAMORPHOSED. METAMORPHIC, INTRUSIVE, AND VOLCANIC ROCKS SEDIMENTARY ROCKS TERTIARY (7) CRETACEOUS UNCONFORMITY PENNSYLVANIAN AND UNCONFORMITY UNCONFORMITY Dps OR OLDER DEVONIAN AND SILURIAN

DESCRIPTION OF MAP UNITS

This map is generalized from Brosgé and Reiser (1964). Many of these map units are combinations of units shown separately on the older map. The Devonian and Devonian (?) age that was assigned to the metamorphic rocks by Brosgé and Reiser (1964) is herein revised to early Paleozoic or older.

SURFICIAL DEPOSITS Qu Unconsolidated sedimentary deposits (Quaternary)

FOSSILIFEROUS PARTLY METAMORPHOSED SEDIMENTARY ROCKS

Kqc Quartz pebble conglomerate (Cretaceous) PM1s Lisburne Group (Pennsylvanian and Mississippian) and Kayak Shale (Mississippian) -- Limestone,

dolomite, shale and conglomerate Dhf Hunt Fork Shale (Upper Devonian) -- Slate and phyllite Dps Purple and green slate and phyllite (Devonian) Dpsa Purple and green andesitic volcanic sheared conglom-erate (Devonian)

Dcs Chloritic siltstone and grit (Devonian) -- Schistose; in part graywacke Dls Limestone and siltstone (Upper Devonian) -- Schistose;

includes some green slate locally DSsk Skajit Limestone (Upper and Middle Devonian, Upper

Silurian) -- Limestone, dolomite, and marble METAMORPHIC, INTRUSIVE AND VOLCANIC ROCKS

Tvb Vesicular olivine basaltflows (Tertiary?) mig | Migmatite (Mesozoic and older) -- Intercalated mica schist and granite; granite with mafic inclu-

gr Granitic rocks (Mesozoic and older) -- K/Ar dates of biotite are 101 m.y. and 125 m.y. (Brosgé and Reiser, 1964); of hornblende, 486 m.y. (M. L. Silberman and D. L. Turner, written commun.,

JURASSIC TO MISSISSIPPIAN

Mafic rocks and chert--Pillow basalt, andesite, minor chert; diorite; diabase and gabbro. Chert (ch) differentiated where abundant

umf Ultramafic rocks

erate (Devonian)

MESOZOIC(?) AND PALEOZOIC

gs Greenstone and greenschist--Includes pillowed flows in Hunt Fork Shale (Dhf) in northeast part of the quadrangle

hs Hornblende schist--Mostly hornfels facies ph Phyllite and schistose wacke

PALEOZOIC OR OLDER qms Quartz muscovite schist

gms Garnet mica schist--Mostly hornfels facies

bss Biotite staurolite schist--Hornfels facies cfs Undifferentiated calcareous schist (csm) and

feldspathic chloritic schist (fcs) Csm Calcareous schist, marble and tactite (t)

cas Chloritized amphibole schist--Local remnant

glaucophane fcs | Feldspathic chloritic schist--Includes meta-

> diorite sills and pyritic quartzite GEOLOGIC SYMBOLS

_____ CONTACT--Dashed where approximate; dotted where concealed.

NORMAL FAULT--Dashed where inferred, queried where doubtful; dotted where concealed; U, upthrown side; D, downthrown side

THRUST FAULT-Queried where doubtful; dotted where concealed. Sawteeth on upper plate

GEOCHEMICAL SYMBOLS

 Sample locality Anomalous values of antimony. Histogram shows values for symbols

• Anomalous values of niobium. Histogram shows values for symbols

DISCUSSION

This geochemical map shows the distribution and abundance of antimony (Sb) and niobium (Nb) in -80 mesh (177 micrometers) stream-sediment samples in the Chandalar quadrangle, Alaska. The map is one of a series of geochemical maps that together with the background information circular (Reiser and others, 1979) comprise the folio on the Chandalar quadrangle, Alaska. The data are plotted on a subdued base map showing the generalized geology, topography, and sample localities. Map symbols showing the ranges of metal values are indicated on the accompanying histograms and all values shown are considered anomalous. An explanation of sampling, preparation, analytical procedures, and geochemical raw data for all samples are discussed by O'Leary and others (1976). The -80 mesh (177 micrometers) stream sediment medium was used in this study because, given the rather restrictive time and manpower constraints, this sample medium together with panned concentrates were considered to be the most economical and adequate media in this area of the north-central Brooks Range, where clastic sediments are derived from local bedrock. The study area is one of generally high relief with short fast-moving streams and broad glacial valleys. All samples were taken from active streams, as close to the center channel as possible. All sediments were considered to be locally derived. Care was taken, when sampling an obviously glaciated terrane, to sample above or upstream from morainal material, wherever possible. Most samples were taken in areas where bedrock was within 30 m of the sample site. Due to the high limit of determination for antimony by spectrographic analysis (100 parts per million), all the samples collected in 1975 for this study were analyzed for antimony by the atomic absorption method. Spectrographic antimony values for samples collected prior to this study were not used. Most of these previously collected samples are from the area between the North Fork and the Middle Fork of the Chandalar River and south of the Squaw Lake-Grove Creek valley in the central part of the quadrangle and are discussed by Brosgé and Reiser, 1970, 1972.

GEOCHEMISTRY OF ANTIMONY AND NIOBIUM

Antimony

Antimony is an oxiphile element and readily combines with sulfur to form antimonides with heavy metals, mostly copper, silver, iron, nickel, and cobalt (Rankama and Sahama, 1955). It is strongly enriched in late stages of magmatic crystallates, often accompanying mercury, and is commonly found in metalliferous veins of volcanic regions. In the weathering cycle, antimony is precipitated in the hydrolyzates and becomes enriched in oxidate sediments, chiefly by adsorption on ferric hydroxide. Antimony, thus, tends to be concentrated in shales and clays and in the Chandalar quadrangle is commonly found in streams draining areas of Hunt Fork Shale (Dhf). Antimony is a good indicator of deposits in which it is concentrated, and is a useful indicator of other types of deposits as well, particularly those of silver, gold, copper, lead, zinc,

Niobium

and mercury (Boyle, 1974).

Niobium is a lithophile element and is concentrated in late crystalates during magmatic differentiation (Rankama and Sahama, 1955). It shows pronounced concentration in granites and this is evident in the large number of occurrences in granitic rocks (gr) along the southern edge of the Chandalar quadrangle. Because of similar ionic sizes niobium can substitute for titanium in the titanium minerals sphene, rutile, and perovskite. Rutile and sphene are common to abundant in many of the nonmagnetic fractions of panned concentrates from the granitic rocks. Zircon also may contain up to 2 percent niobium, and, because of its resistate nature and its wide distribution in igneous rocks, may account for many anomalies. Economic quantities of niobium may occur in pegmatites as niobates associated with tungsten, antimony, tin, bismuth, beryllium, rare earths, and uranium (Boyle, 1974). In the weathering cycle niobium is accumulated in the hydrolyzate sediments and deposited in clays (Rankama and Sahama, 1955). Since many of the minerals containing niobium are resistate to mechanical and chemical

indicator of its deposits (Boyle, 1974). STATISTICAL DATA

weathering, it is relatively inert and is a good

There are four sections of statistical data included with this map: (1) Two histograms show frequency (number of samples) plotted against concentration in ppm (parts per million). Analytical values qualified by an N indicate that an element was not detected at an established lower limit of determination (1 ppm for Sb and 20 ppm for Nb). Analytical values qualified by an L indicate that the element was detected, but at a concentration below the lower limit of determination. A short tabulation of statistical information is included with each histogram. (2) A correlation diagram shows correlation coefficients in the upper part (in decimal fraction of 1) and the number of sample pairs used in the correlation in the lower part. The correlation coefficients and number of sample pairs for antimony and niobium are shaded on the diagram. A coefficient of 1 indicates a perfect direct proportional relation, -l an inverse relation. The significance of a coefficient is directly proportional to the number of sample pairs used in determining that coefficient. (3) A cumulative frequency plot shows cumulative frequency plotted against concentration in ppm for Sb and Nb. (4) Two perspective plots, show a three-dimensional representation of anomalous Sb and Nb in the Chandalar quadrangle. A grid was arbitrarily applied to the quadrangle to give the best representation of values and the metal values of samples in each grid cell were averaged. The peaks shown reflect this average. The plateaus in the perspective plots represent an arbitrary anomalous value (shown on the histograms as a line pattern), usually the 95th percentile or two standard deviations above the median. Because N and L values were used only in the histograms and cumulative plots and not in the computation of other statistical information, the results may be somewhat biased.

OCCURRENCES Antimony

of the Chandalar quadrangle and is probably related to areas of Hunt Fork Shale (Dhs). The antimony content of shales is commonly 3 ppm (Rankama and Sahama, 1955). A clustering of anomalies from stream sediment samples in the northwest corner of the quadrangle is associated with Zn, Mo, and Cu anomalies and may be related to potential massive sulfide type deposits off the quadrangle to the west (Marsh and others, 1978a, b). Numerous antimony anomalies occur in the northeast corner of the quadrangle along both sides of the North Fork East Fork Chandalar River. These along with many other elemental anomalies (Marsh and others, 1978a, b, c, d) and a broad, weak aeromagnetic high (Cady, 1978) may indicate mineralization from a deeply buried pluton.

Antimony is ubiquitous in the northern part

Antimony occurs in the gold district in the central part of the quadrangle, but is not shown on this map because a prior study was made of this area by Brosgé and Reiser (1970, 1972), and because most of the analyses were done by the spectrographic method. Antimony is listed as a minor resource in this area (DeYoung, 1978) and stibnite (Sb₂S₃) was noted by Mertie (1925). A field trip to the gold district in 1976 provided hand specimens of vein material containing gold, sulfide minerals and scorodite (FeAsO₄·2H₂O) (Marsh and others, 1978d). Several large antimony anomalies on the east border of the quadrangle, south of Chekhechunnjik Creek are associated with base metal, rare-earth, and nickel-cobalt anomalies (Marsh and others, 1978a, b, c) as well as similar metal anomalies in nonmagnetic panned concentrates (Detra and others, 1977). Sphene, tourmaline, zircon, rutile, and fragments of schist were observed in the concentrates. These anomalies may

represent mineralization along a fault zone in quartz-muscovite schist (qms) (Brosgé, oral commun. 1976). South of this area, north of Thazzik Mountain, in quartz-muscovite schist (gms) are scattered antimony anomalies which extend westward into the quartz-muscovite schist (qms) between Middle Fork Chandalar River and Flat Creek. These are associated with rare-earth, boron, and niobium anomalies (Marsh and others, 1978c, d) and tin and tungsten anomalies in the nonmagnetic fraction of panned concentrates (Detra and others, 1977). These anomalies may represent a potential for rare-earth pegmatites in this area, although none are known to exist. Scattered low level anomalies occur in the southwest corner of the quadrangle, and seem to be associated with the mafic rocks and chert unit (mrc) which crops out in the area. These are probably normal background values as antimony is commonly found in volcanic rocks. Minor antimony anomalies are scattered south and west in a band from the Geroe Creek altered area

(T. 33 N., R. 5 W.) to the southwest border of the quadrangle. This band generally follows the regional structural trend and includes the copper skarn zones along Big Spruce Creek (Marsh and Wiltse, 1978) the potentially mineralized areas south of the Geroe Creek altered zone (Marsh and others, 1978a, b), and the area of gold placer operations south of this band from the west side of Big Lake (T. 31 N., R. 9 W.) to the Middle Fork of the Koyokok. These placer gold occurrences may be derived from rocks within the antimony zone.

Niobium

Niobium, in contrast to antimony, is predominant

in the southern part of the quadrangle, primarily in the granitic rocks (gr) and migmatite (mig). Its geochemistry would predict this and its common occurrence in the resistate titanium minerals and zircon would make its presence in stream sediments understandable. Niobium also occurs just west of the Geroe Creek altered area and along the regional structural trend to the southwest. These occurrences combined with other elemental anomalies (Marsh and others, 1978a, b, c, d) may indicate the potential for concealed mineralized intrusive rocks. Several niobium anomalies in the area of Big Creek, in the south-central area of the quadrangle are associated with base metal, rare-earth, and boron anomalies in stream sediments and tin, beryllium, and tungsten anomalies in nonmagnetic panned concentrates (Marsh and others, 1978a, b, c, d; Detra and others, 1977). An aeromagnetic high is also associated with this area (Cady, 1978) and may represent buried, mineralized intrusive rocks. Niobium occurs in the southeast corner of the map in two areas: (1) around Thazzik Mountain and westward in quartz-musovite schist (qms) and biotite-staurolite schist (bss) and (2) in granitic rocks (gr) just east of Sixtyone Mountain. In the first area niobium is associated with rare-earth, boron, and antimony anomalies (Marsh and others, 1978c, d) and tin and tungsten anomalies in nonmagnetic panned concentrates (Detra and others, 1977) and may indicate rare earth pegmatites although none are known in the area. A second area, granitic rocks (gr) west of Sixty-one Mountain, also contains niobium, rare earth anomalies, and the only reported uranium values (Marsh and others, 1978c). This area contains a pluton with a distinct aeromagnetic high (Cady, 1978). Panned concentrates from this area contain abundant rutile and sphene

REFERENCES

and rare earth anomalies.

Boyle, R. W., 1974, Elemental associations in mineral deposits and indicator elements of interest in geochemical prospecting: (Canada) Geological Survey of Canada, p.

and some allanite, which may account for the niobium

Brosgé, W. P., and Reiser, H. N., 1964, Geologic map and section of the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-375. _____, 1970, Chemical analyses of stream sediment samples from the Chandalar and eastern Wiseman

quadrangles, Alaska: U.S. Geological Survey Open-File Report. , 1972, Geochemical reconnaissance in the Wiseman and Chandalar districts and adjacent region, southern Brooks Range, Alaska: U.S. Geological Survey Professional Paper 709. Cady, John W., 1978, Aeromagnetic msp of the Chandalar

Chipp, E. R., 1970, Geology and geochemistry of the Chandalar area, Brooks Range, Alaska: Alaska Division Mines and Geology Geologic Report 42, Detra, D. E., Smith, S. C., Risoli, D. A., and Day, G. W., 1977, Spectrographic analyses of heavymineral concentrate samples and chemical analyses of organic samples from the Chandalar quad-

quadrangle, Alaska: U.S. Geological Survey

Miscellaneous Field Studies Map MF-878-C.

File Report 77-543, 151 p. DeYoung, John H., 1978, Mineral Resources Map of the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-878-B. Marsh, S. P., Detra, D. E., and Smith, D. C., 1978a,

rangle, Alaska: U.S. Geological Survey Open-

Chemical and generalized geologic map showing distribution and abundance of molybdenum, copper, and lead in stream sediments in the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map, MF-878 D. _____, 1978b, Geochemical and generalized geologic

map showing distribution and abundance of zinc in stream sediments in the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map, MF-878 E. _____, 1978c, Geochemical and generalized geologic map showing distribution and abundance of nickel, cobalt, yttrium, and lanthanum in stream sediments in the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-878 F. _____, 1978d, Geochemical and generalized geologic

map showing distribution and abundance of

barium, arsenic, boron, and vanadium in stream

sediments in the Chandalar quadrangle, Alaska:

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Marsh, S. P., and Wiltse, M. A., 1978, Composite geochemical map showing major alteration zones and detailed geologic maps of selected mineral deposits, Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map, MF-878 I. Mertie, J. B., Jr., 1925, Geology and gold placers of the Chandalar districts, in Brooks, A. H. and others, Mineral resources of Alaska, report on progress of investigations in 1923: U.S. Geological Survey Bulletin 773, p. 215-263. O'Leary, R. M., McDanal, S. K., McDougal, C. M., Day, G. W., and Marsh, S. P., 1976, Chemical analysis and statistical data for stream sediment samples from the Chandalar quadrangle Alaska: U.S. Geological Survey Open-File Report 76-492, 120 p. Rankama, K., and Sahama, T. H. G., 1955, Geochemistry: The University of Chicago Press, 912 p. Reiser, H. N., Brosgé, W. P., DeYoung, J. H., Cady, J. W., Hamilton, T. D., Marsh, S. P., and

Circular 758.

[Upper half of table contains correlation coefficients; lower half is the number of pairs of values used to compute coefficients. Where number of pairs is less than the total number of samples analyzed the bivariate frequency distribution was censored owing to the limitations of the method of analysis (L, N, and G values were not used in the correlation)]

Albert, N. D., 1979, The Alaskan Mineral

mation contained in folio of Geologic and

rangle, Alaska: U.S. Geological Survey

Resource Assessment Program: Guide to infor-

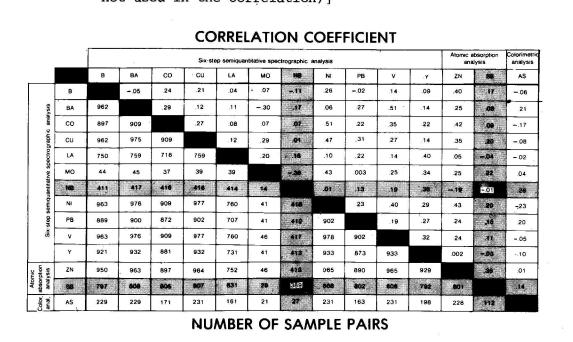
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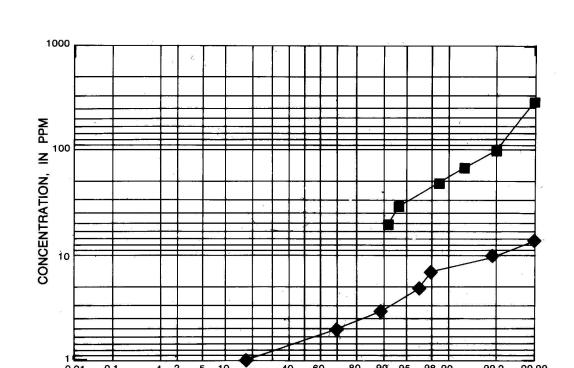
Sb Nb, GEOCHEMICAL MAP

FOLIO OF THE CHANDALAR QUAD., AK

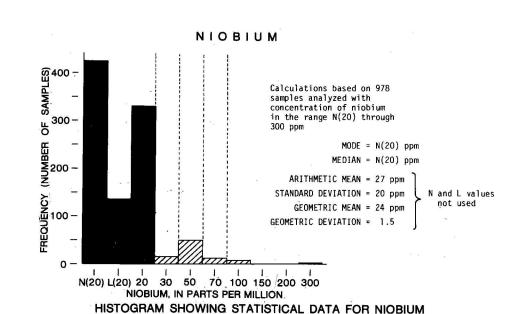
MAP MF-878F



CORRELATION DIAGRAM FOR NIOBIUM AND ANTIMONY IN STREAM SEDIMENT SAMPLES CHANDALAR QUADRANGLE, ALASKA



CUMULATIVE FREQUENCY, IN PERCENT CUMULATIVE FREQUENCY PLOT FOR NIOBIUM () AND ANTIMONY () IN STREAM-SEDIMENT SAMPLES, CHANDALAR QUADRANGLE, ALASKA



IN STREAM-SEDIMENT SAMPLES

CHANDALAR QUADRANGLE, ALASKA

ANTIMONY MEDIAN = 2.25 ppm ARITHMETIC MEAN = 2.4 ppm STANDARD DEVIATION = 1.5 ppm GEOMETRIC MEAN = 2.1 ppm GEOMETRIC DEVIATION = 1.6

1 1.5 2 3 5 7 10 15 ANTIMONY, IN PARTS PER MILLION HISTOGRAM SHOWING STATISTICAL DATA FOR ANTIMONY IN STREAM-SEDIMENT SAMPLES CHANDALAR QUADRANGLE, ALASKA





GEOCHEMICAL AND GENERALIZED GEOLOGIC MAP SHOWING DISTRIBUTION AND ABUNDANCE OF ANTIMONY AND NIOBIUM IN STREAM SEDIMENTS, CHANDALAR 10 X 30 QUADRANGLE, ALASKA

PERSPECTIVE PLOT OF ANTIMONY

IN STREAM SEDIMENT SAMPLES

CHANDALAR QUADRANGLE, ALASKA

PERSPECTIVE PLOT OF NIOBIUM

IN STREAM-SEDIMENT SAMPLES

CHANDALAR QUADRANGLE, ALASKA

S. P. Marsh, D. E. Detra, and S. C. Smith 1979